MAKING 5G MM-WAVE WORK IN THE CAR

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MOBILE EXPERTS

Mobile Experts had the opportunity to participate in a field trial recently, testing the Verizon Ultra Wideband mm-wave network using a variety of smartphones in a moving vehicle. We recorded the speed and reliability of the network with the basic commercial network, then again with a set of two Movandi repeaters attached to the vehicle.

This white paper reports the results of our simple testing.

THE TEST SETUP:

We chose to test the Verizon network in Cupertino, California, where the terrain is flat, the buildings are fairly low at 1-2 stories, and the load on the network is fairly low (office workers in the area are working at home due to COVID). Along N. De Anza Blvd, Verizon has installed gNodeB radio hardware roughly every 300 meters, (every 7th street light), with trees also lining the street.

We used two Galaxy S21 handsets and a Galaxy S10 Ultra 5G handset to conduct speed testing, using the Ookla Speedtest app. We also tested continuity with a video conferencing application with HD video.

We sat in the rear seat of the car, holding the handset in two positions, in our laps and up in front of our faces, with the windows closed. We tested the network speed in various stationary positions and also while moving at approximately 30 mph along De Anza Blvd.

Figure 1 A Verizon gNodeB in Cupertino, California

BASELINE CASE:

Our control test was to simply test the speed of the network in a stationary position, inside the car. In a fixed position, as expected, we experienced good performance from the network, with throughput ranging from 1.9 Gbps (one phone) to 3.2 Gbps (two phones). The reliability of the link was highly dependent on the position that we held the handset in the car, presumably due to attenuation from other bodies, as well as the glass and steel of the car.

[1] Cover photo courtesy of Movandi

Moving at 30 mph, the 5G mm-wave link was spotty. At times, we saw throughput in the range of 200 Mbps to 1 Gbps, but the link was not consistent. Video conferencing was not possible as the link was not stable for more than 5 seconds at a time.

Figure 2. Two repeaters mounted in a Lexus

REPEATER CASE:

With Movandi BeamXR Indoor powered smart repeaters mounted at the windshield and the rear window of the vehicle, our results were far superior. Throughput of 1.7 to 1.9 Gbps was consistent (one handset). Throughput did not change with the phone held in different positions. Also, video conferencing was smooth at HD resolution with no hiccups.

We noted a Signal-to-Noise ratio improvement of 6-8 dB for the repeater system when the vehicle stopped, but in the case with the repeater enabled, this SNR variation did not affect throughput measurably.

CLOUD/EDGE COMPUTING MAKES IT WORK

The repeater solution that we tested includes Movandi's BeamX cloud software, where machine learning and AI are used to determine the best data path. In this test, LTE was used to transmit GPS, speed, and RF data to the BeamX cloud application in real time. The cloud software dynamically assesses the data, determines the best signal path and which repeater array should be used. The cloud app instructs the repeaters to steer their beams in anticipation of the vehicle movement.

This approach does not rely on the smartphone to do any computing, which prevents any battery impact or issues with multiple handset vendors adopting software. In this way, a network equipment provider can offer a solution with great channel performance in the field. The difference is obvious to an end user in range, consistency and speed.

The steel frame of a car/train/bus can be problematic. But with mm-wave repeaters built into the vehicle, performance can be fast and consistent.

OUR CONCLUSION:

Today's 5G mm-wave networks are well designed for pedestrian users on the street, but a great deal of outdoor mobile data is consumed inside vehicles: Cars, trains, buses, etc. Our experience so far is that the attenuation of the glass-and-steel enclosure is problematic for any significant mobile usage in these bands.

However, with mm-wave repeaters built into the roof of the vehicle, we believe that performance can be fast and consistent.

Figure 3 Two handsets combine for a total of 2.9 Gbps (downlink) and 145 Mbps (uplink)